BIO-DYNAMICS

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MULCHING — RIGHT OR WRONG?

E. E. PFEIFFER

Mulching is an almost ideal practice in farming, and even more so in gardening, in order to protect a soil against excessive sun-rays and drying out, against losses of humus because of intensive oxidation (especially in southern, warm climates), and against losses of moisture. The cover of a forest soil, with leaves or needles which decompose slowly underneath the shade of the trees, is a natural mulch process. This natural cover of forest soils teaches us all the good aspects of mulching, especially moisture conservation, but also all the dangers of a permanent mulch cover: the separation from air and therefore increase of acidity, water-logging, one-sided microflora with preference given to fungi, stratification underneath and eventually podzolization. The prevalence of humic acids is definitely a double-edged sword. One-sided mulch as, for instance, in a monoculture of conifers, from pine needles, is rather hostile to many other plants. New seedlings will settle and flourish only if this mulch is occasionally scratched, broken up and interrupted and the soil underneath aerated.

From all these observations, we already learn that mulch is a remedy at times but can become damaging at other times. Those who want to mulch successfully need to make themselves familiar with a few basic rules and need, especially, to understand the purpose of mulching and when and for how long it has to be applied.

These are the basic rules: If a soil is well drained, the mulch will protect the soil against evaporation of water, that is, water losses. Underneath in the cool, moist atmosphere, humus will be preserved and more humus will be produced. This mulch should not be so thick as not to let air circulate and eventually rain penetrate. This mulch is ideal in a dry and hot season. In wet and cool seasons, it can do great damage by collecting and retaining water. Such a mulch in an orchard in a wet season can do a lot of damage, as was reported to us during the summer of 1958. Many a mulch fanatic (there are such people) has blamed everything else as the cause of trouble in his orchard,

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while, had he removed the rotting, mulch cover, he would have solved most of his problems. When told to do so, he answers, "Well, didn't you say mulching is important?". "Yes, my friend," I reply, "but under conditions . . ."

We differentiate between two kinds of mulches — the nourishing mulch and the protective mulch. The *nourishing* mulch is a soil cover, to last for a certain period of time and then to decompose gradually. This mulch, in order to be able to decompose completely at the end of its purpose or function (latest at the end of the season), should be a compost in a certain state of breakdown, most likely a half or three-quarters broken down compost. This means that the compost is not "raw", showing a structure, odor and appearance of any of its raw sources — manure, straw, leaves, garbage or whatever. The first smelly breakdown phase should be over. On the other hand, this compost should not be so advanced as to be earthy because then it can not serve as mulch any more. Should this compost contain a lot of fibre, as in leaves or straw, so much the better for its task as a mulch. This compost can be enriched; that is, it can contain a sizable amount of nitrogen, phosphate, potash, trace minerals or lime wherever required. Half-rotten leaf mold makes an excellent material. Tall weeds with strawy stems make excellent material, provided that they have been cut before they have a chance to go to seed. Mustard, ragweed and stinging nettle make excellent nourishing mulches. At the end of their task or of the season, the leftovers can be worked into the soil surface by any method of cultivation (plowing harrowing, digging, hoeing, etc.) In orchard management with no cultivation, there will usually be a good grass sod development. The grasses can be mown and left as hay mulch, especially in cases where it is planned to change from no cultivation to open soil cultivation. It should be kept in mind, however, that any cut grass or hay cover may choke out the grasses underneath. This applies even to grass cuttings left on a lawn. If the aim is to maintain the grass cover, it will be necessary to rake the hay together and to remove it before the grasses underneath are choked, that is, get yellow and begin to die.

The protective mulch: This kind of mulch has the sole purpose of protecting the soil against moisture losses and hindering evaporation of water. These mulches will be especially beneficial during dry periods. It is evident that these will perform best if applied while there is still moisture in the ground. An-

ticipating the weather is frequently guesswork. One will therefore make certain errors, namely, apply the mulch and then have a long period of moist and rainy weather. The mulch may rot or an acid, waterlogged condition may develop underneath. In such a case, the mulch should be loosened up, should not remain packed and eventually might even need to be removed.

Protective mulches give little in the way of nutrients to the soil. Such mulches can be hay, straw, salt hay, weed straw, leaves, bagasse, even paper, polyethylene or other plastic materials which can be rolled on and off. Stone mulch would also be classified in this category.

All mulches properly applied will foster the development of a very fine humus and crumbly soil structure underneath. On sandy soils, the water retention will be especially beneficial. On very heavy clay soils which offer considerable structural problems and are hostile to cultivation, a mulch may be the only way to render them crumbly. In such cases, the clay should be reasonably dry and the mulch should not be applied too early, that is, not on wet clay.

The dangers of mulching: The greatest danger consists in the fact that mulch hinders the access of air and that a waterlogged condition may develop. Many mulched orchards during the wet spring and summer of 1958 encountered more trouble and harm than good, and the development of fungus diseases became excessive. If a mulch gets moldy, this means it was too wet, then the soil will become acid under it and no nitrogen assimilation is possible. Such mulches should be removed before they become harmful. This means that mulching is not a practice to be followed stubbornly under all circumstances but should be done with good common sense and an understanding of its function. The effect of mulching depends on the observation of the conditions of soil and weather — wet or dry.

Another danger exists when mulches are left over the winter. If the soil is well covered with any fibrous, loose material (hay, weeds, leaves), these might become the ideal hiding and hibernating quarters for insect pests. Mice and rats just love to tunnel under the protection of this kind of mulch; rodent damages to the lowest part of the trunk of a tree go unnoticed. Soggy mulch also is a good breeding place for fungi.

Under climatic conditions where frost plays a role, there is nothing more natural and better than frost action on a soil to produce a crumbly structure, provided the frost can freely pene-

trate and the soil is well drained. A waterlogged, soaky mulch which freezes and thaws is of no help and only acts as an insulator; does not even keep the soil warm and does not protect against frost damage to sensitive plants. The freezing out of plants during the winter is increased with waterlogged conditions of the soil or mulch.

Even snow acts as mulch. Underneath the snow, the soil warms up to about the depth that the snow is thick. Two feet of snow would penetrate with its warming effect about two feet deep.

We hear many an orchardist complain about curculio damage. This beetle is a very nasty one, difficult to combat, especially if one does not want to apply poisonous sprays. In letting mulches lay over winter, one creates the best condition for its hibernating. If it gets the upper hand, I see no other way but clean cultivation over the winter and jarring right after blossoming time, at the first mating season. One spreads a paper underneath the tree and shakes the branches thoroughly early in the morning at sunrise when the beetles are still cold. In a small orchard where every tree is a beloved pet and treasure, this is not too much work. Heinz Grotzke recently showed me how he could collect 200 curculio in a few minutes. This, done for several days, will decimate the pest. If the trees, leaves and the setting fruit have been covered with the after-blossoming tree paste spray, one has a good chance to control the curculio. This is then a question of proper "sanitation" of the orchard's ground floor.

Finally, no mulch should come close to the trunk of a tree. There should always be an open collar of one to two feet around the trunk. This "collar" can be level or slant away from the trunk, never towards it.

For all the reasons described, we feel that alternating of cover crops, (sods), with open cultivation and mulching during the critical season (dry season) might offer the best sanitation.

Mulching against weeds has to be done with a protective mulch, thick enough or impenetrable enough so that weeds are choked out. Chopped straw or bagasse are excellent for this purpose; even paper or plastics. These should lie long enough to hinder the weeds from growing. Straw or layers of leaves as mulch for this purpose need to be at least two inches thick.

Grapevines, cane and bush berries and strawberries respond very well to mulching; in fact, all row crops where the distance

between rows is reasonably wide. Recently we have experimented with the application of the tree paste sprayed directly on the ground, between rows, and even covering the plants while they are young. This has offered an excellent protection; rain penetrates through this cover but evaporation is hindered and good humus forms underneath. This spray can be very thin and will last many weeks.

Another method of mulching is the pouring of a paper pulp mulch on perfectly level land. This, again, offers a perfect cover. This method is applicable to small gardens but rather costly for large areas, for a tremendous amount of paper is needed to get a pulp cover of, say, ½ to 1 inch. One builds a frame around the bed and pours the liquid mulch into it.

In southern dry and hot climates, mulching during the summer is most essential, especially if no irrigation water is available. Care should be taken that such mulches do not become a fire hazard, as is the case with a thick layer of dry straw, hay or paper.

To sum up: mulching — yes, by all means, but with the use of good common sense.

INDIRECT BENEFITS

Biodynamic farmers and gardeners stand a chance of eventual benefits from a relatively small item recently ground through the mills of our Government at the instance of those concerned with the effects of mass spraying, not on man but on our country's piscine population. An appropriation of $280,000 for pesticide research by the Bureau of Sport Fisheries and Wildlife and the Bureau of Commercial Fisheries was retained in a money bill passed by both Houses of Congress on June 15th and thus cleared for Presidential signature. For the basic information, we are indebted to the "Conservation Report" of the National Wildlife Federation.

The amount of money involved is relatively small, far more should, of course, be spent on such research and on studies of ecological and other non-deadly means of pest control. Yet it is an encouraging symptom among so many that are anything but that, and it points to an important principle. If people can, somehow, have a problem brought to them in terms of *their own interests* far more is likely to happen than through the most eloquent appeals for something which, to them, is an abstraction.

F. H.

THE TOMATO

HEINZ GROTZKE

As a commonly used vegetable, the tomato is a relatively young food plant. Although it is a native of continental America, it was grown for its nutritive value in Europe first, in 1835, prior to its cultivation in the United States. The tomato was, however, very well-known — centuries before Columbus' discovery — to the native people of Central and South America. These countries, Peru especially, are the home of this now well-established food plant. This origin indicates that the plant species developed in a climate of low humidity and high temperature. These facts should be kept in mind when growing the tomato as a vegetable.

Its nutritive value lies in its content of vitamin A (1100) and iron (0.6 mg per 100 g). The protein amounts to 1%, the fat 0.3%. 94.1% is water, compared to the cucumber with 96.1%. Among the vegetables, the tomato is an outsider, distinct from other garden varieties. It exhibits its individuality by its eagerness for food, the strength of its vegetative forces, and its desire to grow in a soil enriched with decomposed tomato matter. No other plant grows well on its own manure; they often leave substances in the soil which prove toxic to plants of the same variety. Not so the tomato. A well-decomposed compost of tomato-vines and fruits serves as the best stimulant. Bio-dynamic gardeners preserve these residues for this purpose.

Since the tomato is accustomed to a warm climate, unable to withstand freezing temperatures, the plants must be started indoors. This is necessary because the time between sowing and late harvest is longer than the period of frost free days. The first hard frost in fall determines the length of harvesting. In order to make tomato-culture economical, the harvesting should be stretched out to extend over a period of at least eight weeks. Practices of growing transplants and frost protection can prolong this period to twelve weeks.

Three steps are involved in growing a sturdy, well-rooted tomato plant: sowing the seed, transplanting the young seedling, and potting the young plant. Sowing is done best in a low flat (3 inches high) which is filled to about 1.5 inches with a well rotted sandy compost, a compost made preferably from weeds, grass-sods, and leaves. The soil should be screened, made level in the flat and slightly packed. The seed is equally distributed over the area and carefully brought into close contact with the

soil by applying pressure with a small board or glass pane. As the seed requires darkness for germination, it is covered with just enough soil or sand to make the seeds disappear. Sand is ideal because the seedling can easily push through it, and it accurately shows the absence of moisture. For the beginning horticulturalist, this method prevents the establishment of damping-off and other fungus diseases. However, it is extremely important to wash the sand thoroughly, before using, to remove all traces of chlorides and other toxic elements. After the seed has been covered, a glass pane is placed over the entire flat to retain moisture and keep out mice or other animals. A sheet of paper is laid on top to prevent the sun from generating excessive heat in the air space of the enclosed flat. The ideal germination temperature is around 80 degrees F.

A bio-dynamic gardener will use seed that has not been treated with any of the chemical fungicides, especially those used to coat seeds. The seeds should remain free from these inorganic compounds which might stimulate the formation of virus particles. The best solution is to purchase seeds from plants grown on soil treated with bio-dynamic compost. The seeds should also be such that the seed lobes emerge easily from their hulls, an indication that they have been harvestd from ripe fruit.

As soon as the seedlings break through the ground and start unfolding their lobes, glass and paper must be removed from the flat to permit light to penetrate and turn the leaves green. Perhaps about six days will have passed by then. The soil should be moistened with water of the same temperature (or higher) than the air surrounding the plants. I prefer to water in the morning in order to allow time for the plants to dry before night. If possible, watering should be avoided on cloudy days to discourage the growth of fungi. Watering is considered an art by professional gardeners as great harm can unwittingly be done.

About ten to fourteen days after sowing, the young seedlings will be ready for transplanting. By then, the seed-lobes will be fully developed and a dark green in color. The exact time for transplanting arrives *after* the seed-leaves have assumed a horizontal position, and *before* the first root develops side-roots. This means that there is only one root, which is the extension of the stem. To proceed, the soil in the flat is loosened and only that many seedlings are removed as can be transplanted in a few minutes, since the sensitive roots rapidly dry out, es-

pecially if exposed to sunlight. Flats, about five inches high and filled with a balanced compost mixture, which includes wood-ashes, should be used. Generally, the compost material is screened, the coarse elements used to fill the bottom of the flat, the fine, the top. Proper aeration and drainage are maintained and the structure will be similar to natural soils. Before the seedling is planted into this bed, its root is pinched off, keeping one inch, stimulating the formation of side-roots. The plant is then set into the flat deep enough for the soil to cover the root and the stem up to the seed-lobes; it is set deeper than before when it was growing. The soil is pressed tightly around the root and levelled again. They can be planted as close to one another as 2.5 inches. Water the plants and allow them to grow in a sunny spot. The only work for the next four weeks is watering, and loosening the soil occasionally.

Soon the tomatoes become so crowded in their flats that they must be separated. They are now transplanted into clay pots, three inches at least in diameter. The soil mixture should be more coarse than fine and should include about 1/3 well rotted manure compost. It is good practice to add wood-ashes to supply potassium. Care should be taken not to use wet soil, which has a muddy texture. It should be brought in a few days prior to use, time enough to allow it to warm up and dry out sufficiently to prevent the sensitive plants from coming down with "cold feet". Plants are removed from the flats with as much soil attached to the roots as possible. The seed-leaves (probably yellowish by this time) are pinched off, and, after placing a little soil in the bottom, the plant is settled into the pot. Again, the tomato is potted deeper than it grew before, up to the point where the first true leaves emerge from the stem. The pot is filled with soil and pressed down with slight pressure. The soil is then watered not the plant itself.

Another four weeks will probably pass before the weather permits the tomatoes to be planted in the garden. During this interval they should be kept cool to insure a sturdy growth. Enough light is an essential. In case unfavorable weather delays planting, and the plants outgrow the pot and exhaust the nutritive resources of the soil, they should either be transferred to larger pots or the soil should be refreshed with a liquid fermented chicken-manure.

The field to receive the tomatoes should be prepared with a generous application of half-rotted compost and plowed, if

this has not already been done in the previous fall. Tomatoes will do well in almost any type of soil, yet there is an ideal spot where they prefer to grow. In my opinion, it is that wet spot which every farmer can show you on his farm, but which might be difficult to discover in a garden. Such a spot signifies that the soil receives moisture from ground water or a hidden spring, indicating a connection to the subsoil. In most cases, these spots will be on the acid side, but tomatoes can tolerate this, since, above all, these plants desire the water in the soil and avidly seek it by sending down roots six feet and more. Therefore, any hardpan in the soil should be broken before planting tomatoes, the farmer using a subsoiler, the gardener a spade. In a small garden, it is worthwhile to dig a ditch, 2-3 feet deep and fill it with raw cow-manure, making sure, however, to provide room for about one foot of soil on top of this. The tomato is a plant, which can adequately handle raw substances, actually requiring them for the initial stage of its vegetation. After the ditch has been filled and leveled off again, a row of tomatoes is most suitably planted in the center of the ditch. Half-rotted compost may be mixed with the top-soil, and preparation 500 is sprayed on the ground before planting.

After the plants are allowed to harden-off, they are ready to be set into the garden. The pots are soaked with water a few hours before the event, and — in those cases where clay pots were used — removed from the pots with enough care not to destroy the ball of roots. The lower, yellowish leaves are plucked, and the plants are again set into the soil as deeply as possible without causing damage to the roots. The practice of setting the tomato deeper into the soil with every transplanting is done because this plant can form roots from every part of its stem. These are valuable feeder-roots, which increase the absorption of plant nutrients from all layers of the soil. The vegetative growth that results is stimulated and guarantees a larger crop. For the same reason, tomato plants are generally hilled after a few weeks. Thereafter, the field can be mulched to preserve soil-moisture and protect soil life. The distance of planting varies according to the method employed.

Tomatoes may either be allowed to grow into bushes without any pruning, or may be staked or grown on strings, which does require pruning. The first method demands a planting distance of 48 x 36 inches, the second one 36 x 24 inches. Advantages to be gained by the first method are a higher crop

from fewer plants, and the time saved on pruning. It is generally followed by commercial growers who supply canning companies. The second method is more advisable for the gardener, and is being adopted, more and more, by producers selling to the common market. Advantages are an earlier crop of better quality and less time needed for harvesting.

Staking tomatoes requires pruning of all but the main stem, which is tied to the stake with raffia or soft rope. All suckers, growing in the joints between the main stem and the leaves have to be cut off with a sharp knife without causing damage to leaf or stem. The blossom clusters grow out of the main stem, and the variety which sets these clusters close together is the best. Practical methods of cultivation and fertilization have an influence. Some gardeners allow only four or five clusters to develop and pick off all others that might form.

Growing tomatoes on strings is possible when you have a wire tautly suspended five feet above the ground, onto which the strings are fastened. Winding them around the stem keeps the tomatoes erect. The advantage of this method is that two or even three stems can be trained from one plant. This delays ripening a bit, but increases the yield per plant. It is an attempt to combine the virtues of the other two methods; it is also gaining favor among commercial growers. Another point in favor of this method is that the strings are burned after being used once, while stakes last several years and generally demand annual disinfection to control disease transmission.

Tomatoes love water in the soil as much as they dislike it in the air or on their leaves. Continual moisture in the air or on the leaves favors fungus diseases; in their natal country, dry air prevails. Therefore, all irrigation should deliver water to the soil only. In a field of hilled tomatoes this is achieved by flooding the aisles between hills. It is worthwhile for gardeners to plan their planting with this in mind. To avoid cracking of the fruit, there should be a steady supply of moisture. If irrigation becomes necessary, plenty of water should be applied at a time, to be followed by cultivation.

Irrigation may be combined with fertilization. A first rate fertilizer is chicken-manure, fermented in water. 20 lbs of chicken manure in 50 gallons of water is allowed to ferment for three weeks, with frequent stirring, then diluted with two thirds of water for use. The response of the tomato plants will easily be observed. The best time for this is when the blossoms

are in bloom. I also found that a solution of earthworm castings, sprayed on the leaves, is successful. Wood-ashes may be added to this liquid. In this case, the fertilizing elements are taken in through the leaves.

Next is an application of 501, sprayed on the leaves as soon as the vegetative phase ceases and the fruiting stage predominates. This foliage spray is a complement to preparation 500, and active only if the latter has been applied. 501 enhances the assimilation of solar energies, increases the yield, and heightens resistance to disease.

Gardeners experienced in bio-dynamic methods recommend another spray which helps to keep the tomato plant healthy. I previously mentioned the practice of growing tomatoes repeatedly on the same place. It was Dr. Steiner who suggested this in lectures given to farmers. It was found that the success of this method could be increased by immersing all pruned suckers and sideshoots in water and allowing them to decompose. This liquid is then sprayed on the tomato-vines and aids in mustering resistance against insects and pathogens.

The question of when and how to harvest should present problems to no one. Color is the guide. Yet tomatoes are picked at different stages of maturity, depending upon the market they are sold to. A vine-ripened tomato is one that has the best quality in taste and juiciness. Nothing can substitute for the process of ripening by the sun.

As soon as the tomato field is cleared of its crop, preparations for the next season should start. In one way or another, tomato-vines and fruits should be introduced into the soil; the idea being to have them decompose before next season, a process that is aided by the B.D. Field Spray. A cover crop for green manuring is valuable for soil improvement, and should be planted as soon as possible. Rape or mustard are ideal, rye, however, must be chosen if planting is delayed until the late fall. The preparation of the soil is one key to B.D. tomato growing, because the health of the plants is intimately related to it. Only by correct soil management can tomatoes be grown in the same field year after year. The application of the other bio-dynamic practices then guarantees premium crops.

For the home gardener, the same principles hold, although they may be adapted to individual conditions. For a few tomato plants, I probably would choose the following method. In autumn I would dig a ditch about 3 feet deep and dump in it,

throughout the winter, all kitchen garbage, wood-ashes, manures, etc. In spring, the rest of the ditch is filled in with soil and leveled off. Later on, the tomatoes are planted right on it. Repeat this every year.

Briefly, tomato growing in greenhouses will be mentioned. The advantage is that the water can be so accurately regulated that not a trace will ever wet the leaves. The spacing may be as close as 20 inches, and they are most often grown on strings. Only the main stem is allowed to develop, pruning is done frequently. Since the tomato blossom is wind-pollinated, the air should be kept in circulation, or the tomato agitated by shaking the wire to which the strings are tied. The temperature should be maintained at 65 degrees F, as an average, with higher temperatures on sunny days. Watering should be done in sunny weather only. Bio-dynamic practices are the same as previously discussed. Hilling is most frequently used.

In tomato growing, an insect problem rarely exists. The only insect that ever gave me trouble was the wireworm in the soil. This is the larval form of the click-beetle and does its damage by eating its way through the stem. This pest may become a problem, especially when the field was previously grown in grass, or the content of organic matter very low. An effective way to get rid of them is to put pieces of potatoes into the infected soil, to which the wireworms are attracted. These pieces are examined every week, and the worms in them captured. I have been informed by some gardeners that the cutworm sometimes attacks young tomato plants. This insect is the larva, this time, of a moth. Advanced gardeners, using electric insect traps, will find many adult moths among the trapped insects. An infected area should be checked each morning. Cutworms feed at night and a wilted tomato plant is symptomatic. It will be easy to find the culprit not more than a foot away from the plant, buried in the ground.

Tomato diseases are much more frequent than are insects. Treatment, however, is relatively easy since no distinction in remedy has to be made for different diseases — in bio-dynamic gardening. They are mostly favored by rainy and humid weather. Strict bio-dynamic cultivation practices diminish outbreak to a minimum. Unfavorable weather demands a re-application of 501, perhaps with a supplemental spraying of horsetail tea and camomile. A liquid manure of stinging nettle is yet another measure. The spread of diseases late in the season, such

as late blight, should not be taken too seriously, since it is part of the aging processes of the plant.

Before concluding this article, a few words about the relatives of the tomato. It is a member of the nightshade family, and related to food plants such as potatoes and peppers. All three are unique because of their demand for raw animal manure. *This* is the material which can be utilized for their vegetative growth! The gardener, who responds to the "craving" of these plants for a generous supply of such material will be rewarded with a bumper crop. Plants of this family really seem to take in those life forces still contained in the manure. Other nightshades contain toxic principles, such as the deadly nightshade (Atropa belladonna) and tobacco. Poisonous substances are even found in our nightshade foodplants, in parts other than those we use for food, or in food portions before they reach maturity.

BIOLOGICAL CONTROL OF NOXIOUS INSECTS AND WEEDS

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In our last number we carried a report of one of the sessions of the Twenty-fourth North American Wildlife Conference held in New York City earlier this year. It told of marked differences of opinion among the scientists concerned, as to the effects of some of the newer chemical pesticides on organic life.

A few days before the conference, and frequently dealing with related problems, there had taken place the 23rd Annual Convention of the National Wildlife Federation. The following paper was presented at that convention. While the author maintains that the use of insecticides is "currently necessary", he presents a clear picture of the present state and the potentialities of biological control *— the control of an animal or plant through the action of other living organisms.*

I sincerely appreciate your invitation to discuss the biological control of noxious insects and weeds. It is estimated that we have 10,000 injurious insects in this country and in spite of many effective control measures insects still cause losses of about $4,000,000,000 each year. Weeds are replacing large acreages of otherwise desirable rangeland in the West.

To control insects which threaten our food and fiber supply and transmit deadly diseases to man and his crops and livestock, entomologists recommend several methods including cultural practices, biological-control agents, crop varieties resistant to insects, and a vast array of insecticides. Biological-control agents are important checks on many destructive pests, but when they do not give the degree of control required for production of good crops of high quality, growers must resort to other methods. Hence, today, greatest reliance is placed on insecticides. Since certain insects have become resistant to some insecticides, and since some insecticides leave residues that limit their use on certain crops or may be inimical to fish and wildlife, there has been an increasing interest in biological control. Where biotic agents cannot be substituted for insecticides, it may still be possible to use them as supplements and thus reduce the overall amount of chemicals required.

Kinds of biological-control agents. — The term "biological control" means the control of an animal or plant through the action of other living organisms. By control the economic entomologist means holding the population of an injurious insect below the level that causes economic damage. All injurious insects have enemies—insect parasites, predators, or disease-producing micro-organisms, such as viruses, bacteria, fungi, protozoa, and nematodes. Weeds also have insect enemies, and efforts are being made to take advantage of this fact. A number of higher animals, notably mice, skunks, and birds, destroy insects. Agents that exert biological control of insects are either native in this country or they have been produced when conditions were favorable. Without these natural enemies we would be overcome by destructive species. However, the grower and others affected by insects want a method of control that prevents economic damage.

Most of our serious insect pests originated from abroad and became established and flourish in this country without the hindrance of their normal complement of natural enemies. To overcome this situation, entomologists for over 60 years have been making explorations in many parts of the world to find parasites and predators that could be used to control these introduced pests. The importation of beneficial insects is largely a responsibility of the Entomology Research Division. Such importations must be made with great care, for we must be sure that no crop pests are introduced. Practically every parasite or

predator of a pest species has its own natural enemies, known as secondary parasites or hyperparasites. Therefore, before introducing a parasite or a predator into a new area, extreme care must be taken to prevent also introducing its natural enemies. After they have been through quarantine, parasites, predators, and other beneficial insects are sent to Federal or cooperating State laboratories for release or for rearing and colonization prior to release, after which there are recovery programs to determine their effectiveness against specific pests.

Use of biological-control agents.—Advocates of biological control point out that it is Nature's way of keeping a reasonable balance in populations, and that it is a cheap method. The introduction of specific agents that have been unusually successful against certain pests has borne this out. On the other hand, most of the introductions made thus far do not provide economic control of serious pests. Of course, the availability of biological-control agents that meet this test would obviate the use of insecticides and also help solve the increasing problem of resistance as well as attendant residue problems. Without man's help we can hardly expect them to control most pests. Nature usually provides a balance in numbers so that the predator and the plant or animal host all survive. Therefore, biological-control agents alone will not solve all insect problems.

The use of insecticides to control pests or to supplement natural control is currently necessary. In some cases the insecticides upset the balance in favor of the destructive insects. This is not always true, however, Recent claims have been made that parasites and predators of the spruce budworm and the gypsy moth have been destroyed by DDT and that conditions will be worse than before spraying. Such claims are unsubstantiated. Studies show that stages of beneficial insects concealed at the time of spraying, even inside the insect host being sprayed, survive and subsequently attack survivors of the injurious species.

It is gratifying to note that more studies are getting under way to find ways of using biological-control agents in combination with sprays under circumstances where the beneficial organisms alone cannot provide economic control. Another possibility is to propagate beneficial insects and disease organisms and release large numbers under favorable conditions in an effort to get quicker and better results.

I will now cite a number of cases where different biological-

control agents have been used for the control of noxious insects and weeds on crop land, pastures, and forests

Parasites and predators.—About 95 introduced parasites and predators of insect pests are now established in the continental United States, whereas approximately 390 species were imported and colonized but failed to become established (Clausen 1956). C. P. Clausen, a widely recognized authority in this field, states that "The results of biological-control work in the continental United States for more than 60 years indicate that only a small portion of our most important agricultural pests can be fully controlled by this method and that with a substantial number of them no reduction whatever can be attained. However, most of the biological-control projects may be expected to yield a partial control, the benefits derived therefrom being in the form of reduced injury to crops and a lower total cost for chemical and other means of control that still need to be practiced." (Clausen 1956)

Over 20 species of parasites of the oriental fruit moth, involving thousands of specimens, introduced from Europe, the Orient, and Australia from 1930 through 1939 to control this pest of peaches in the eastern United States, failed to be of value, although several species multiplied rapidly immediately following their release. However, the native parasite *Macrocentrus ancylivorus,* previously reared only from the strawberry leaf roller, adapted itself to the oriental fruit moth and caused a fairly high degree of parasitization. Heavy liberations of reared parasites have resulted in a 50 to 80 percent reduction in fruit injury. In an effort to eradicate the oriental fruit moth from California, over 48 million of these parasites were released in infested orchards and greatly outnumbered the host, but the parasite failed to become established (Clausen 1956).

The Comstock mealybug became of commercial importance in apple orchards of Virginia, West Virginia, and several other eastern States during the 1930's. From 1939 to 1941 hymenopterous parasites were introduced from Japan, and within a few years they brought the pest under complete control.

Of 15 natural enemies of the Japanese beetle introduced from the Orient between 1920 and 1933, five have become established but only two wasps, *Tiphia popilliavora* and *T. vernalis,* which attack the grubs in the soil, have contributed materially to its decline in numbers. It has been difficult to evaluate the efficiency of these parasites, which occasionally attack

up to 65 percent of the grubs in the soil. These parasites have undoubtedly prevented buildup of the pest, but in spite of their help as well as other control measures, this beetle continues to spread southward and westward.

Undoubtedly one of the outstanding illustrations of effective biological control was the importation, in 1888, of a ladybird beetle from Australia to California to control the cottony-cushion scale on citrus. The initial investment of less than $5,000 resulted in benefits to our citrus industry amounting to millions of dollars annually. It has been standard practice to purchase these ladybird beetles from commercial sources when needed to control this scale.

During the last 30 years over 3 million parasites of the European corn borer have been imported from Europe and the Orient and equal numbers reared in this country have been released to help control this destructor of corn. Of 24 species imported and colonized, 6 have become established and 2 are of considerable importance. The parasitic fly *Lydella grisescens* is probably the most effective species, being widely distributed with field parasitization ranging from 10-75 percent. The wasp *Macrocentrus gifuensis*, is found largely in the eastern States and parasitizes up to 52 percent of the borers. These parasites have undoubtedly been of great value in reducing losses by this major pest, but the control is inadequate to prevent economic loss and further spread.

Great interest has centered about a recent study in North Carolina involving the control of hornworm larvae on flue-cured tobacco by *Polistes* wasps. In a number of localities the wasps, provided with inexpensive shelters that protected their nests and brood from larger predators, increased in abundance and reduced moderate hornworm infestations to noneconomic levels. This is an example whereby improving the environment for the predator tipped the balance in its favor.

Disease-producing micro-organisms.—These micro-organisms—bacteria, fungi, viruses, protozoa, and nematodes—have not been studied as exhaustively as parasites and predators for the control of insect pests. Some lack of interest may have been due to earlier studies linking their effectiveness with the weather and also the importance of accurately timing applications. Nevertheless, since certain microbial agents can be produced at a reasonable cost, are generally harmless to plants and animals, and are apparently unaffected by insecticides, they war-

rant far more study. Some important findings have already been made as indicated by the following examples, but yet they are rarely used to provide economic control of pests.

Japanese beetle grubs live in the ground, where they may be attacked by several bacteria, principally *Bacillus popilliae*. When the larvae ingest the spores, they develop milky disease and die. The spores persist in the soil and revitalization occurs by infection of invading grubs. Methods have been found whereby these spores could be produced in living grubs and processed with talc to produce a dust. The spore dust has been widely distributed and of considerable value in holding down Japanese beetle populations. With the further spread of the beetle and the need for nonchemical control methods, there has been a renewed interest in this disease. Research by the Department is under way seeking to produce the bacterium economically on an artificial medium in order that it may be available for more widespread use in lieu of chemicals.

The virus *Borrelina campeoles* has proved highly effective in controlling the alfalfa caterpillar in California. It can be applied with field sprayers or from airplanes. However, it is difficult for growers to recognize the need for treating in time for the virus to be effective against the fifth-instar larvae, which are the most damaging.

An important recent development is the experimental control of the tobacco hornworm under field conditions in the Carolinas with sprays containing dried spores of the bacterium *Bacillus thuringiensis*. In some tests the spore treatment has proved as effective as endrin, the most effective insecticide. Unfortunately, the spore spray does not control the budworm and other insect pests of tobacco, for which insecticides must still be used. It is impractical for the grower to apply a biological-control agent for one pest and an insecticide for another, if he has an insecticide that will control both species. Several companies are producing this bacterium which shows promise against a number of insect pests. Used in sprays and in granules in field tests it has caused mortalities of 45 to 70 percent of first-brood corn borers.

Recent tests by this Division in cooperation with the Forest Service have shown that spraying with a water suspension of a polyhedrosis virus on small plots can establish the virus disease in the Great Basin tent caterpillar, which is a serious defoliator of aspen. During the first year the mortality never exceeded

50 percent, but in the second year it was fatal to almost all the full-grown larvae.

The Entomology Research Division's Insect Pathology Laboratory is one of the Agriculture Research Service's 15 recently established pioneering research laboratories in which insect pathologists are conducting basic investigations in this comparatively new field. Their studies will include the identification of pathogenic organisms, the conditions under which they may cause epizootics in insect populations, and methods of culture for possible practical application.

Higher animals.—Studies by Morris *et al.* (1958) indicate that the effect of birds and mammals on the spruce budworm population during outbreak years has been negligible, the predation by birds being probably less than 1 percent. They found that birds and parasites responded directly but ineffectually to a rapid and sustained increase in budworm population. Studies should be carried out when populations are low, at which time birds may be of considerable importance in preventing their increase.

Weeds.—The classic example of biological control of a weed in this country is the importation from Australia and Europe of several insects to destroy the Klamath weed. This weed is not only poisonous to livestock but displaces desirable range plants. Chemical control proved expensive and much of the infested land was inaccessible. Two species of *Chrysolina* beetles proved to be specific to Klamath weed, and within two years after liberation they became well established and soon widespread in California, from which they were redistributed locally and to other States (Holloway and Huffaker 1952). In California alone more than 100,000 acres have been returned to useful production, and grateful cattle and sheep growers have recently erected a monument in honor of these beetles.

Plant resistance to insect attack.—Some plants show more resistance to insect attack than others. Either they lack certain qualities that would attract the insects or they possess qualities that may adversely affect the insects' growth or permit the plants to withstand infestations that would severely injure susceptible plants. The development of a new variety involving hybridization followed by selection usually requires six to ten years (Painter 1958). Thus, such an approach to insect control is a long-time venture, but when successful it is of long-lasting value.

The development and release by various experiment stations of seven varieties of wheat resistant to the hessian fly is an excellent example of this type of insect control. Plant breeders and entomologists have developed two varieties, Pawnee and Ponca, which in 1956 were grown on about 60 percent of the wheat acreage in eastern Kansas, where previously the hessian fly had reduced the crop by about a million bushels each year. When Ponca was grown outside its area of adaptation, it still retained its fly resistance and agronomic value, but millers disliked it because it did not fit into their milling program (Painter 1958).

A number of hybrids resistant to the European corn borer have been distributed in the North Central States. The reduction in infestation results primarily during the feeding of the first-instar larvae in the whorl. Research has also shown that borer survival in resistant hybrids is at least 50 percent less than in susceptible ones. With such a reduction in each generation, it should not take many generations before the insect would become almost nonexistent. Many of the corn hybrids grown in Ohio are resistant to the borer.

The spotted alfalfa aphid, a destructive pest of alfalfa, invaded the western States in 1954, and by the end of 1956 was found in 30 States. An early discovery was that Lahontan, a variety best suited to the irrigated valleys of the inter-mountain area for which it was developed, had excellent resistance to the aphid. Subsequently varieties Moapa and New Mexico 16 were developed for other areas, and research continues in an effort to find more varieties adaptable to other new areas that may become infested with this aphid.

Irradiation.—One unique new approach to insect control, which is not entirely biological, involves the large-scale release of males sterilized by gamma rays from a cobalt-60 source to destroy the reproductive potential of natural populations of the screw-worm fly. Losses caused by this pest cost livestock men in the Southeast as much as $20 million a year, and there are also large wildlife losses. When a sterilized screw-worm male mates with a native female, she will lay only infertile eggs in the wounds of animals. Therefore, repeated releases of a preponderance of sterilized males gradually decrease the reproductive potential of the natural population and lead to ultimate annihilation. This idea was conceived by E. F. Knipling, director of the Entomolgy Research Division, and much laboratory

and field testing by our research scientists preceded the dramatic eradication of the screw-worm from the island of Curacao in 1954 (Knipling 1957).

After additional research on mass rearing of screw-worms, sterilization of the pupae, and the development of improved devices for releasing the flies from airplanes, a 2,000 square mile field study was conducted that confirmed the practicability of a large-scale control program. In 1957 the State of Florida and the U. S. Department of Agriculture undertook a multimillion-dollar eradication program to free the Southeast of this pest. The Animal Disease Eradication Division of the Department and the State of Florida erected a tremendous fly-rearing facility geared to produce 50 million flies per week. Sterilized flies have already been dropped over about 70,000 square miles in Florida, southern Georgia, and southeastern Alabama. It appears that the natural screw-worm populations have been eliminated in all but two counties in Florida, and prospects are good that this pest will be eradicated from the Southeast.

Because the sterile-male-technique approach to insect control appears promising, preliminary studies are under way in our Division against other insects, including fruit flies, the sugarcane borer, the boll weevil, and mosquitoes.

Research needs. There is need for further biological and ecological studies on many of the insects injurious to agricultural crops and trees to determine which biological-control agents show the most promise. What are their host relationships, including competition between species, and what influence do weather and other environmental factors have on their effectiveness? These agents must be readily obtainable and provide economic control or they will not be acceptable to growers as replacements for insecticides. Studies are also needed to develop the best integrated program on their utilization to the maximum advantage with a minimum use of insecticides. Explorations should be continued to find enemies of the undesirable insects and weeds from foreign countries which have become established in this country. The possibility of developing improved strains of these natural enemies through breeding or hybridization should be investigated.

A neglected field involves the mass rearing of biological-control agents and an evaluation of widespread liberations over extended periods of time. The releases or treatments would be

similar to an insecticide schedule, and possibly economic control could be obtained under such circumstances. These studies would require the development of economical mass-rearing techniques utilizing suitable hosts, synthetic diets, or artificial culture media. Tissue-culture methods are needed for the propagation of insect viruses and for the production of growth-regulating horomones that might prove useful as insect controls. Regardless of the biological-control agents used, research should be conducted to determine the precise timing required in favorable environments if the organisms are to be effective and available in time to prevent damage by the pest insect. Studies are also needed to determine the underlying causes of epizootics. Ways must be found to hold or store biological-control agents to insure their ready availability.

Studies should be made abroad of insect enemies of noxious weeds already established in the western United States, including halogeton, gorse, Scotchbroom, Dalmatian toadflax, puncture vine, and tansy-ragwort. A tremendous field is open for the development of varieties of crops resistant to insects. It takes a long time to get results in crop-improvement programs of this nature, and perhaps that is the reason such research is poorly supported. Resistant plants sometimes upset the physiology of insects, and studies are needed to determine whether they may thereby become more susceptible to insecticides, diseases, or their enemies. It is urgent that studies be conducted to ascertain the usefulness of the sterile-male technique against destructive pests other than the screw-worm for it may prove effective, reasonable in cost, avoids residues and other problems that follow the use of some insecticides.

The Entomology Research Division is cognizant of the advantages and limitations of many control methods and is striving to meet the most urgent problems within available resources. Efforts are being concentrated on new approaches to insect control, to safer chemicals, and to ways of employing chemicals with a maximum margin of safety.

Summary.—Natural biological-control agents are important in checking noxious insects and weeds, but their acceptance by growers in lieu of chemicals or other methods depends upon their furnishing economic control. They can be used to supplement insecticide or other methods when they cannot accomplish this purpose alone. The effectiveness of parasites and predators is illustrated by examples of their role against the

oriental fruit moth, Comstock mealybug, Japanese beetle, cottony-cushion scale, European corn borer, and tobacco hornworm; of bacteria for control of the Japanese beetle, tobacco hornworm, and European corn borer, and virus diseases of the alfalfa caterpillar and the Great Basin tent caterpillar; of birds and mammals against the spruce budworm; by beetles to control Klamath weed; by resistant varieties of plants against the European corn borer and spotted alfalfa aphid, and by irradiation against the screw-worm.

The importance of biological control warrants a heavy investment in future research to evaluate the effectiveness of outstanding parasites, predators, and diseases against many destructive insects. The development of crop varieties resistant to insect attack provides an efficient and long-time control of insects, but research work on many insects and crops is lacking. The use of the sterilized-male technique in insect control for pests other than the screw-worm is practically untouched.

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A NEWSPAPER ITEM

The following will not be *news* to regular readers of Bio-Dynamics, but your editors felt it was worth reprinting for a number of reasons. When some of us started working, years ago, for this scientific method of organics, it would have been startling indeed to find such an article in a daily newspaper and one would have probably "passed out cold" to learn that its source was a research man at one of the State Colleges. All of which goes to show that the world does move, and that along with many negative developments, such as, for instance, the

widespread use of the chlorinated hydrocarbons, there are encouraging things happening also.

The clipping, sent us by our good friend E. S. Hansch of Portland, Oregon, is from the Oregon Journal, a Portland daily, and appeared on November 24, 1958. The item follows:

"Oregon State College, Corvallis, Nov. 24. — What is the soil's primary crop? Microbes, says an Oregon State college scientist, who has won the 1958 OSC campus research award for his work with soil microorganisms.

"Dr. W. B. Bollen points out that the millions of minute microorganisms in the soil are the essential key to soil development and fertility. They 'unlock' the potential fertility of organic matter and minerals and make it available for plant use, with benefits that must be measured in millions of dollars.

"Some 100,000 million million microorganisms — bacteria, actinomyces, molds, algae and protozoa — are found in an acre of soil sliced to a depth of 7 inches, Bollen explains. Their dry weight would approximate 1,000 pounds.

"Add to these a half ton of earthworms (or 2,000,000 to 10,000,000) per acre and you get an idea of the mass of living organisms in fertile soil, he continued.

"Bacteria and molds in the soil use plant and animal residues as food and are active in transforming them to humus and available plant nutrients. They also are responsible for a gradual liberation of available food for the plant from the insoluble soil minerals and from 'unavailable' or locked-up fertilizer materials, he said.

"For good plant growth, therefore, fertilizer and soil management practices must be aimed at building up the soil in organic matter as well as in mineral nutrients, he said. Such procedure feeds the soil first, then the crop."

PLEASE!

The editors have said it before, but it needs to be re-emphasized:

Please do send us reports, long or short, of your practical experiences in field and garden. Only with many more such items can this quarterly come closer to fulfilling its purpose. We have found that people often don't realize that things that happen to their soil and plants in the growing season can be most interesting and helpful to others. We hope that many more will *join us* in working for Bio-Dynamics.

BOOK REVIEWS

A NEW CONCEPT OF WATER

Most of us who live in cities and towns nowadays think of water as something that comes out of a faucet when we turn it, something that is necessary to quench our thirst, to wash our clothes and bathe in. Of course we also read in the newspapers of floods, of droughts, of huge dams being built here and in other parts of the world to control floods, to provide electricity and to ameliorate drought conditions through irrigation. There are also some of us who can remember when the water that came out of the faucet in the city did not reek of chlorine.

Then there are a few rare individuals who have an entirely different concept of water. Unique among these is Joseph A. Cocannouer who, on the basis of over sixty years of working with soils and water in many parts of the world, has written a book called WATER and the Cycle of Life, published by The Devin-Adair Company, New York, 1958. Professor Cocannouer writes with zest and vividness about what he calls *Quality Water* and what it means to plants, animals and man. Indeed, one finds it hard to lay the book down.

This *quality water* is, of course, water that has been "conditioned" by nature, carried through certain cyclic processes. Such water is just right for animals to drink, and grows plants which are full of health-giving properties for both animals and man to eat. These conditioning cycles have been upset by the interference of man. Professor Cocannouer opens his book with instances of the effects of man's interference with these cycles. This is followed by chapters on the various phases of the natural processes. Then he closes by telling us how we can again approach the production of *quality water* by working with nature. The measures he describes here are things to be done in addition to the large-scale projects of water conservation, things which will help these large projects to remain useful for longer periods of time. Some of these suggestions are smaller dams upstream from the larger dams, farm ponds, restoration of watershed protection, etc. Naturally these things will take a long time. However, his eleventh chapter recounts what was done in such a watershed which, in the words of the people who are still living there, had seemed beyond repair. Those people stayed on and did their share in renewing life in the area, and this story gives one hope that these conservation problems can be solved in other localities. People must become awake to the problems of

course, and this book of Professor Cocannouer must surely have an effect.

There is a glossary of water terms and an index, besides 120 pages packed with information. For the modest expenditure of $3 one can get a "solid" water education.

ALICE HECKEL

THE SOIL IS NOT A HANDFUL OF DIRT

LIVING EARTH by PETER FARB

with photographs by Ramon Vishniac
Harper and Bros. New York

This is a book that should be on the required reading list of all students of agriculture. Written by a science reporter it contains a great deal of scientific information so presented that it is as easy to read as a book of fiction. The author has done a splendid job of reporting the findings of many scientists, who have done soil research over a period of years. Interspersed between the facts are bits of his own thoughts, which at times verge on the philosophical. In the preface he says, "The apparent lifelessness of a piece of earth is an illusion. Specks of protoplasm swarm through the soil granules, invisible to the naked eye. Larger animals and plants are linked to them by invisible threads of food supply and living conditions. Similarly, there are interlocking relationships between the larger creatures, and so up the pyramid until we come to its apex, the fabric of Life itself." And in chapter one, "There is no soil without life; they are inseparable. The living things make the difference between a mere mass of mineral particles and mineral *soil.*"

Then follow some of the life stories of the innumerable creatures that live in the soil beneath our feet. Mr. Farb divides the soils of the earth into three main types — forest, grasslands and desert. The activities and life cycles of the inhabitants of these soils are described in great detail. Emphasis placed on the interrelation and interdependence of the members of these communities. Their ability to adapt to their surroundings is a paramount factor for their survival. Their helpful as well as their destructive activities are related. For instance he describes how important the much despised termite is in the economy of nature. In the tropics they are the prime agents of decay. They attack and break down the twigs and leaves that have fallen to the ground. If this were not done the debris

would soon choke all vegetation.

The stories of the lives of the inhabitants of the soil are much more complicated and interesting than is known or even suspected by most laymen. Many of these creatures could not exist if it were not for the cooperation of one or more of their neighbors. In the chapter entitled, Mutual Survival, Mr. Farb states, "In the soil, however, and probably also in the other great environments for life on the planet, it is not so important who eats whom — but rather who lives with whom. If there is any secret to survival on the part of the beings underfoot, it may lie in mutual cooperation rather than destruction of other organisms." Symbiosis is a very important factor in the life of the soil and it has been stated that it may even be of primary importance in the origin of new species. There is also an antibiotic activity going on in the soil and this too is discussed briefly by the author. In his final summing up Mr. Farb says, "There can be no life without soil and no soil without life — they are inseparable." And again "What remains after the soil creatures have done their work is humus, a substance which no one knows very much about, in spite of the fact that man has revered it since early Classical times for the fertility it seems to bestow."

This small book (only 167 pages) is informative and entertaining. It is one that B.D. farmers and gardeners will appreciate because it brings together in a very concise, readable form much information that was originally published in writings too technical and numerous for most of us to read.

RUTH EASTMAN

* * *

PATHS ACROSS THE EARTH

by LORUS AND MARGERY MILNE

Harper and Bros., New York

Why do birds fly north in the spring to nest and hatch their young? Why do salmon swim up stream in fresh water to spawn? Why do the spring buck antelope of South Africa make a mass death march every few years? This book does not give all the answers but it does make you ask the questions. And it does give many interesting facts and descriptions of the migrations of birds, beasts, and fish. If you have never looked up in awe and wonder at the flight of a flock of geese, or marveled at the swarming of a colony of bees or been astounded at the efficiency with which ants move their eggs and young from

one place to another, you will start watching for these activities after you have read this book. The authors have followed these paths in their own back yard and in far away places and have written down their observations in a very readable form.

R. E.

FROM OUR SECRETARY'S CORRESPONDENCE

A Gardener from Kentucky, writes:

April 2, 1959

....., and I would be very much interested in learning more about Bio-Dynamic Gardening and Farming.

I live in a city, in a small subdivision, where the land has never been used for agriculture, but only for grazing. .... The lots are large, just 18 homes, well planted, afford protection for wild life ...., and the residents feed the birds and provide houses. The soil is very rich, underlaid with limestone rock, parts being fossiliferous. ....

My lot is, within a fraction, an acre, approximately one-fourth of which I use for vegetable, fruit and berry gardening. Another one-fourth is used for the planting of trees, shrubs and flowers, perennial, annual and biennial. We have dwarf apple, pear and peach trees; blackberries and raspberries; and last year I had 26 different vegetables growing in my garden, which we ate, canned, froze, sold and gave away. Production was tremendous, fine quality and luscious. It was a beautiful garden, ... and naturally I was quite proud of it, and especially since it was my first attempt at vegetable gardening.

I started with a very rich soil covered with mostly bluegrass and bermuda grass, had it ploughed 8″ deep, raked out part of the sod, enough to smooth the ground, and with this sod I started a compost heap in the garden, in a corner. I then spread last year's compost on the soil, added sand, burnt limestone, worked it in the soil and let it stand for three weeks; added 4-12-8, a commercial fertilizer, worked it in the soil; laid out my garden, planted it and after up, top dressed with Nitrate of Soda for leafy vegetables, more 4-12-8 top-dressing for fruit crops; and wood and coal ashes from the fireplace I used to top-dress root crops. Since we had plenty of rain last year, it was necessary for me to use the hose only twice.

Am I right in thinking (I have never had chemistry or physics) that Nitrate of Soda and 4-12-8 are inorganic fer-

tilizers? What can I use to take the place of these and use everything organic in my garden?

My funds for gardening are very limited; I type letters and sew and sell to have money for my yard and gardens. My garden is my hobby, my source of recreation, strength and health, my friends (mostly) and a place where I feel nearest to God, a place where I am the happiest. Also, it means the same to my husband, child and mother — we love it!

Something I can't seem to find information on is the use of egg shells, citrus fruit peelings, vegetable peelings, coffee grounds, etc.; if these are buried in the green compost and covered with earth, will they draw rats — being in the city. ...., surrounded with homes, I have been afraid to try this, and every time we empty the garbage I feel that I am throwing something valuable away. We do have field mice but not to any great extent, possibly due to the owls and sparrow hawks we have around.

I hope I have not bored you with all of this but felt the information would tell you whether or not "Bio-Dynamic Gardening and Farming" is for a home gardener and farmerette like me. Or would it be too technical for me to understand?

Sincerely,

E. W. W.

Answer:

April 18, 1959

Dear Mrs. W.,

It might need more study to "understand" the background of the Bio-Dynamic Method, that is, to develop a functional and biological concept, but it is certainly very simple to apply the practices deriving from it.

The first step in the Bio-Dynamic method is the making of compost with the Bio-Dynamic Compost Preparations 502-507, or the B.D. Compost Starter. The B.D. Compost Starter is the simplest to use and makes compost faster. The use of the Preparations or the Starter in making compost increases the biological value of your compost as fertilizer. The enclosed information sheet explains the value of using the B.D. Compost Starter.

One can increase the effect of any good untreated compost by spraying the compost, or the soil where used, with the B.D. Compost Starter. If you have already used your compost, you can spray that area with the Starter. In either case, cultivate it into the soil, at once.

Commercial fertilizers, e.g., 4-12-8 and Nitrate of Soda, are inorganic fertilizers. The action of inorganic fertilizers is quite different from that of organic fertilizers or, better to say, composts. With the inorganic fertilizers the availability to plant roots is what counts. Compost nourishes soil life and this in turn affects the availability of minerals by bacterial action and enzymes. The organic matter in the soil, turned into humus, acts also as a storage source, from which plants can draw according to their demand.

Wood ashes are strongly alkaline and may harm roots and soil life if directly and concentratedly applied. It is much better to add them to compost, but not to manures, for the alkalinity would release ammonia from uncomposted, fresh manures. Addition of lime to a compost should be used with discretion. On neutral, alkaline and limestone soils lime is not necessary. For the addition of lime I would be guided by the actual demand, which can be established only by a soil analysis.

Bio-Dynamic gardeners bury their garbage in their compost piles. Some sprinkle a little B.D. Compost Starter on the kitchen garbage, then collect it in a larger area, adding a little garden soil until it is convenient to add it to the compost pile. You should not be bothered with odors or vermin.

The first beneficial effect of the Bio-Dynamic method is the improvement of quality. If proper and sufficient amounts of compost are applied the yield also can be very satisfactory. In midsummer you may apply a mulch of partially decomposed Bio-Dynamic compost — this should have an earthy smell but may appear coarse. This will nourish the plants and prevent the drying out of the soil.

It is best to wait until the second year to spray with the Bio-Dynamic Preparation No. 501. This spray is used to stimulate and regulate foliage growth. Preparation No. 500 is used to stimulate root growth to support the stimulation of the foliage growth.

You may be interested in the B.D. Tree Paste Spray for your fruit trees and berry bushes. This spray may also be used for a mulch.

Our basic book on gardening is presently out of print, but there is much valuable information in back issues of BIO-DYNAMICS, and certain pamphlets:

Recommended Articles in BIO-DYNAMICS

The Vegetable Garden Vol. XI, No. 1 & 2

Planning the Home Vegetable Garden	Vol. XII, No. 3
Mulching	Vol. XI, No. 4
Plant Symbiosis	Vol. XI, No. 4
Cold Weather Vegetables	Number 39
A Vegetable Garden from a Wood Lot	Number 39

Price: 40c per copy; the 4 issues for $1.50

PAMPHLETS

Companion Plants & Herbs	.50
Bio-Dynamic Treatment of Fruit Trees, Berries and Shrubs	.60
The Minister's Vegetable Garden	.25

The last pamphlet is not strictly Bio-Dynamic but it is helpful to the home gardener.

Sincerely,

JOSEPHINE PORTER

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